Supporting Information for

The Safe Harbor Agreement and
Candidate Conservation Agreement with Assurances
for the Colorado Pikeminnow, Razorback Sucker, Roundtail Chub, Flannelmouth Sucker, and Bluehead Sucker
in the Middle Duchesne River Watershed, Utah

April 2014

Contents

Statement of Purpose

This document provides detailed supporting information for the 'Safe Harbor Agreement and Candidate Conservation Agreement with Assurances for the Colorado Pikeminnow, Razorback Sucker, Roundtail Chub, Flannelmouth Sucker, and Bluehead Sucker in the Middle Duchesne River Watershed, Utah', hereafter called the Agreement. This package of supporting information was meant to shorten the Agreement, but still provide adequate ecological, geographical, and technical information for the official record.

Description of Covered Area:

The Agreement covers the wetted areas of: the Duchesne River between Myton and Knight Diversions; the Strawberry River between the confluence with the Duchesne River and Starvation Dam; all wetted tributaries to these two rivers with confluences above Myton Diversion and below Starvation Dam or Knight Diversion; and the entirety of the canal systems which have intake facilities between the Myton diversion, Starvation Dam, and the Knight Diversion. Herein after, this area will be considered the “covered area”. The Riverine portion of the covered area is shown in Figure 1 below.

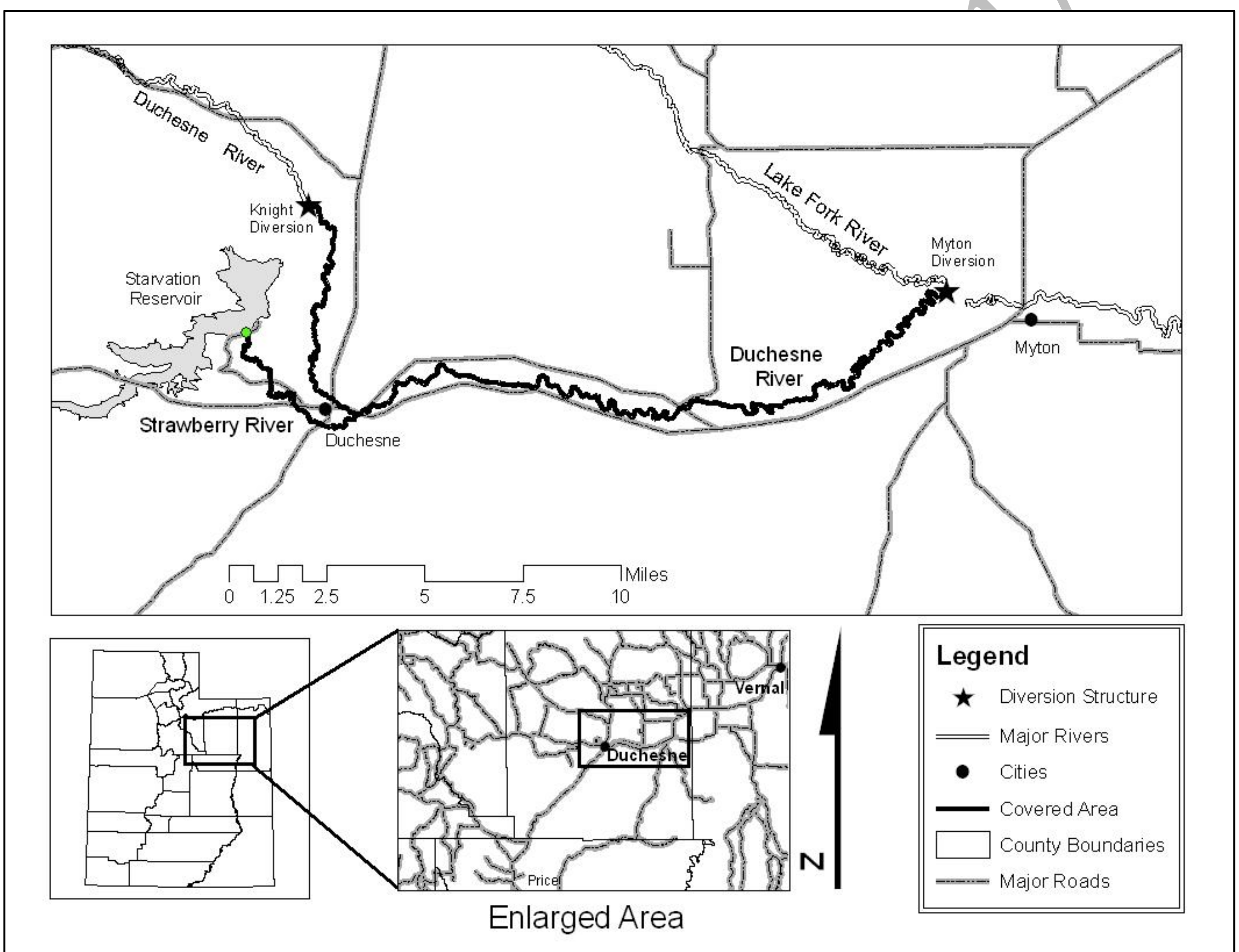

Figure 1. The Covered Area

In the National Hydrography Dataset, the covered area is located within the Green River sub-region and the Duchesne River basin (Table 1). The Strawberry River is a tributary to the Duchesne River, which in turn is a tributary to the Green River. The Myton Diversion is located on the Duchesne River near Myton, Utah. The Knight Diversion is located on the Duchesne River north of Duchesne, Utah. Starvation Dam is located on the Strawberry River west of Duchesne, Utah. A more complex map showing these features is found in Appendix I of this document.

USGS Hierarchy	Name	HUC Digits
Sub-region (HUC4)	Green River	1406
Sub-basin (HUC8)	Duchesne River	14060003
	Strawberry River	14060004
Watershed (HUC10)	Duchesne River	1406000315
	Strawberry River-Duchesne River	1406000304
	Lower Strawberry River	1406000408

Table 1. Watershed hierarchy for covered area

This section describes the current conditions of fish habitat, river flows, and aquatic communities for the covered area as of September 2010. To describe fish habitat, conditions were visually assessed in the field. Information describing river flows are quantified from various sources. Finally, aquatic communities are described by UDWR data.

Description of Current Fish Habitat Conditions in the Covered Area

Observations to assess fish habitat were conducted by UDWR during the summer of 2010 via canoe from the Knight Diversion to the Highway 87 bridge crossing (upper reach) and from the Bridgeland Bridge to the Nielsen property (lower reach). Observed reaches were limited to locations with public access or where permission was granted by the landowner. In the upper reach, land ownership is almost entirely private, with some public access found at the Knight Diversion and at the bridge right-of-way. In the lower reach, tribal land is inter-mixed with state and private holdings. Each of the two observed reaches is approximately five miles long. Together they compose nearly 26% of the covered area.

The UDWR observed multiple lines of evidence that the upper reach was impacted by past and current land use and instream development, including eroded stream banks, low pool/riffle ratios (indicating few pool habitats), high width/depth ratios (indicating poor channel function), and limited riparian vegetation (Figure 2). Stream-side grazing and livestock watering was a common condition. In addition, woody debris was scarce, largely a result of the Knight Diversion limiting the conveyance of upstream large woody debris. Overall, fish habitat is heavily impacted in the upper reach, with substantial room for improvement. In the lower reach, cutbanks are prevalent (Figure 3), the stream is narrow and meandering with thick riparian vegetation (Figure 4), and there is a greater pool:riffle ratio than in upstream locations (Figure 5).

Figure 2. The Duchesne River below the Rocky Point Diversion during spring runoff (15 June 2010). Note the absence of deep pool habitats, width of the stream, and lack of riparian vegetation.

Figure 3. An eroded bank in the Duchesne River above the Nielsen property.

Figure 4. A narrow channel with thick riparian vegetation (though still nonnative) is characteristic of the Duchesne River between the Bridgeland Bridge and the Nielsen property.

Figure 5. Deep pool habitat in the Duchesne River between the Bridgeland Bridge and the Nielsen property.

Observations were made during spring flows, when runoff was greater than water diverted from the stream. During the base flow period, which overlaps with the irrigation season between approximately July 1st and October 31st, the stream looks quite different, as instream flows are significantly less. Decreased stream flow, which is highly regulated and monitored, presents its own challenges for aquatic species present in this reach at this time.

Description of Flows in the Covered Area

Duchesne River flows are well documented throughout the basin via monitoring by the United States Geological Survey (USGS) at multiple locations. Gauging stations are located on the Duchesne River upstream of the covered area at Tabiona (#9277500) and downstream of the covered area immediately below the Myton Diversion (#9295000) and at Randlett (#9302000). Major tributaries to the Duchesne River, upstream of the covered area, are also monitored - the Strawberry River (gauge #9288180) and the Lake Fork River (gauge #09291000). In addition, flows diverted through all Central Utah Water Conservancy District diversions are monitored and transmitted in real-time[1].

Example Flows During 2010

Flows during June 2010 fish sampling did not follow the expected riverine pattern of increasing flows in downstream reaches[2]. In a natural system one would expect flows at the Myton gauge to be approximately the sum of gauges directly upstream (Duchesne River at Tabiona, Strawberry River, and Lake Fork River gauges). In June 2010, the expected flow at Myton should have been 469 cfs based on upstream gauges [200 (Duchesne River at Tabiona) + 127 (Strawberry River) + 142 (Lake Fork River) = 469 cfs]. However, flows were approximately 57 cfs during this time.

The cause of this difference is the many irrigation diversions between these gauges that supply water for agricultural uses[3]. There are four diversions between the Tabiona and Myton gauges on the Duchesne River, and numerous diversions on the Lake Fork River as well. These diversions clearly take out the majority of water between these two gauges, even during spring runoff.

A similar scenario occurred during September of 2010. Flows at Tabiona gauge ranged from 47 to 51 cfs, flows at the Strawberry gauge (which remain high during the irrigation season) ranged from 72 to 77 cfs, and flows at the Lake Fork gauge ranged from 249 to 220 cfs. However, flows at the Myton gauge ranged from 50 to 68 cfs over this timespan, a similarly small portion of the predicted flows. This condition demonstrates that the impact on Duchesne River flows from irrigation demands persist into September.

Despite the many gauging stations in the Duchesne River basin, in-river flows in the covered area are directly not monitored. Therefore, to have accurate flow readings to accompany fish sampling results (discussed in the following section), crews from the UDWR took flow measurements at each sampling site using a Marsh-McBirney flow meter.

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[1] See DuchesneRiver.org website
[2] Downstream reaches drain larger areas and typically include more tributaries, increasing the amount of water available for flows.
[3] Flows were still not the predicted amount when accounting for travel time, demonstrating lag time was not the cause.

Description of Aquatic Communities in the Covered Area

Fish native to the covered area that have not been observed for decades include bluehead sucker (captured in 1976, 1984, and 1991), Colorado pikeminnow (captured in 1931, 1956, and 1968), Colorado River cutthroat trout (*Oncorhynchus clarki*; last captured in 1984), and roundtail chub (captured in 1931, 1971, and 1976). Sampling locations for these captures suggest that each of these species was at one time found from Duchesne City downstream to the Myton Diversion. Bluehead sucker were, at one time, as far upstream as the Knight Diversion

Native fishes captured in both historical sampling and in recent sampling efforts include flannelmouth sucker, mountain whitefish, mottled sculpin (*Cottus bairdii*), speckled dace (*Rhinichthys osculus*), and mountain sucker (*Catostomus platyrhyncus*). In 2004, UDWR crews sampled near the Knight Diversion and encountered several native species (flannelmouth sucker, mountain whitefish, mottled sculpin, mountain sucker, and speckled dace); however, flannelmouth suckers were not observed at this same site during 2010 surveys.

In June 2010, backpack electrofishing was conducted for small-bodied fish in shallower habitats. Immediately above and below the River Road Bridge redside shiner, speckled dace, mountain sucker, flannelmouth sucker, and fathead minnow were captured. Immediately below the Rocky Point diversion, captures included mountain sucker, speckled dace, redside shiner, and fathead minnow. Also in June 2010, two locations were sampled with a beach seine in the lower reach. Results of the first site were similar to upstream reaches except for an increase in redside shiner and speckled dace and a decrease in mountain sucker. The second site was dominated by redside shiners and included only fathead minnow.

In September and November 2010, UDWR sampled seven locations with a barge electrofisher (appropriate for both small- and large-bodied species) between the Myton and Knight diversions (Figure 6). Sampling occurred between the River Road Bridge and the Knight Diversion, above and below the Rocky Point Diversion, upstream from the Center Street (Hwy 87) bridge in Duchesne, upstream from the Bridgeland Bridge, and between the Bridgeland Bridge and Center Street Bridge.

Collectively, native species, mainly mountain sucker, speckled dace, mottled sculpin, and mountain whitefish, dominated fish community composition in the middle Duchesne River, comprising 83.5% of the total (N = 1,272 fish; UDWR 2012). In addition, a total of six flannelmouth sucker were collected (mean ± SE = 149.2 ± 20.6 mm total length (TL); range = 123−252 mm TL; catch-per-unit-effort = 1.41 fish/hr) from four of seven survey sites. Redside shiner and brown trout were the most abundant nonnative species, whereas White Sucker were relatively rare. Fathead minnow, and Utah chub were also present in smaller numbers.

During sampling on September 7-9, flows were 60.0 cfs between the River Road Bridge and Knight Diversion, 38.9 cfs above the Rocky Point Diversion, 0.85 cfs below the Rocky Point Diversion, 7.2 cfs above the Center Street Bridge, and 78.0 cfs above the Bridgeland Bridge. It is important to note that these largely disparate flows are found in the same river, at the same time, in locations separated by only 10-20 river miles, presenting highly variable conditions to the detriment of a persistent/healthy fish community (habitat connectivity, habitat complexity, etc.).

Overall, small-bodied species dominate the fish assemblage in the middle Duchesne River. This is logical, given the drastic reduction in flows in this reach during the irrigation season. Large bodied fish may inhabit the reach between the Strawberry River confluence and the Bridgeland Diversions, which consistently carries irrigation water, as well as other potential refuge areas that were not sampled in this effort. Flannelmouth sucker were captured in most locations, but were rare, and roundtail chub and bluehead sucker may be extirpated from this reach. However, additional sampling in future years may demonstrate that refugia habitats exist for large-bodied fishes during the irrigation season. It is possible that flannelmouth sucker are more common in these locations and that roundtail chub and bluehead sucker are still present.

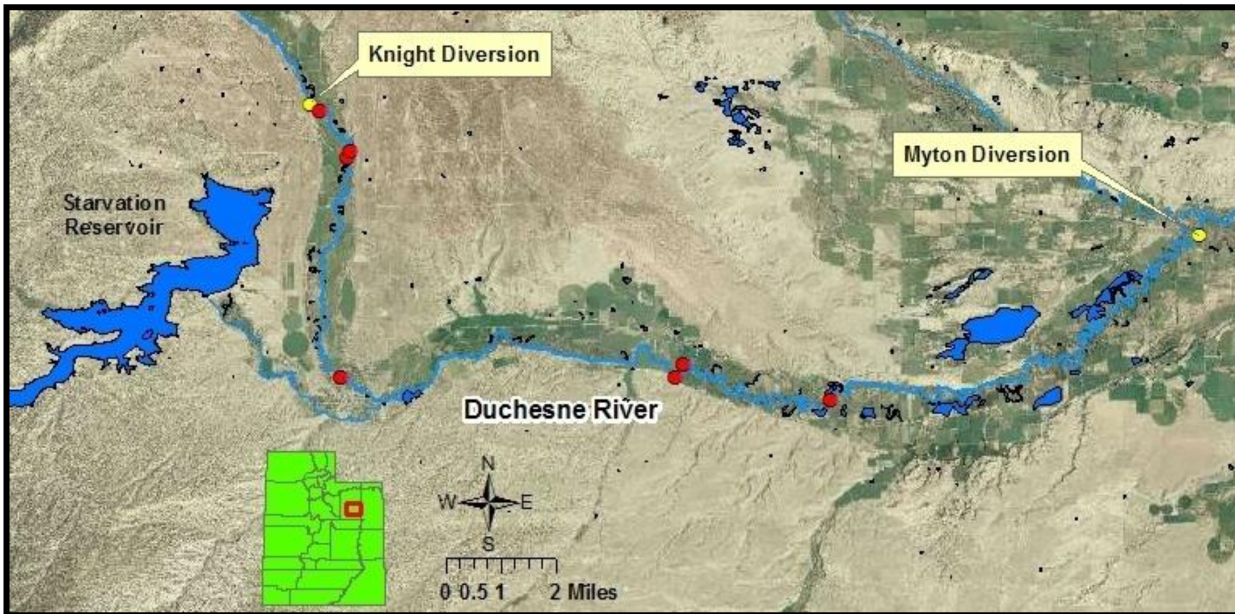


Figure 6. Barge electrofishing in the Duchesne River on 7–9 September and 8 November 2010. Seven sites (red dots; average reach length = 286 m) were sampled between the Myton and Knight diversions to assess fish community composition.

DESCRIPTION OF COVERED SPECIES:

Colorado pikeminnow (*Ptychocheilus lucius*)

The Office of Endangered Species first included the Colorado pikeminnow (as the Colorado squawfish) in the List of Endangered Species on March 11, 1967 (32 FR 4001). It is currently protected under the Endangered Species Act of 1973 as an endangered species throughout its range, except in the Salt and Verde River drainages in Arizona. The U.S. Fish and Wildlife Service (Service) finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002a), but is currently drafting an updated revision.

The Colorado pikeminnow is the largest cyprinid fish (minnow family) native to North America and evolved as the main predator in the Colorado River system. Individuals begin consuming other fish for food at an early age and rarely eat anything else (Sigler and Sigler 1996). It is a long, slender, cylindrical fish with silvery sides, greenish back, and creamy white belly (Sigler and Sigler 1996; Figure 7). Historically, individuals may have grown as large as 6 feet (ft) long and weighed up to 100 pounds (lbs) (estimates based on skeletal remains) (Sigler and Miller 1963), but today individuals rarely exceed 3 ft or weigh more than 18 lbs (Osmundson *et al.* 1997).

Figure 7. A Colorado pikeminnow collected in the Green River in April 2011

The species is endemic to the Colorado River Basin, where it was once widespread and abundant in warm-water rivers and tributaries from Wyoming, Utah, New Mexico, and Colorado downstream to Arizona, Nevada, and California (multiple citations in U.S. Fish and Wildlife Service 2002a). Currently, wild populations of pikeminnow occur only in the Upper Colorado River Basin (above Lake Powell) and the species occupies only 25 percent of its historic range-wide habitat (U.S. Fish and Wildlife Service 2002a). Colorado pikeminnow are long-distance migrators, moving hundreds of miles to and from spawning areas, and requiring long sections of river with unimpeded passage. They are adapted to desert river hydrology characterized by large spring peaks of snow-melt runoff and low, relatively stable base flows.

The Colorado pikeminnow requires relatively warm waters for spawning, egg incubation, and survival of young. Males become sexually mature at approximately 6 years of age, which corresponds to a length of about 400 mm (17 inches (in.)), and females mature 1 year later (Sigler and Sigler 1996). Mature adults migrate to established spawning areas in late spring as water temperatures begin to warm, with migration events up to 745 river kilometers round-trip on record (Bestgen *et al.* 2005). Spawning typically begins after peak flows have subsided and water temperatures are above 16°C (60.8° Fahrenheit (°F))(multiple citations in Bestgen *et al.* 2005). Mature adults deposit eggs over gravel substrate through broadcast spawning and eggs generally hatch within 4 to 6 days (multiple references in Bestgen et al. 2005). River flows then carry emerging larval fish (6.0 to 7.5 mm long (0.2 to 0.3 in.)) downstream 40 to 200 km to nursery backwaters (25 to 125 mi.), where they remain for the first year of life (U.S. Fish and Wildlife Service 2002a).

Colorado pikeminnow reach lengths of approximately 70 mm by age 1 (juveniles) (2.8 in.), 230 mm by age 3 (subadults) (9 in.), and 420 mm by age 6 (adults) (16.5 in.), with mean annual growth rates of adult and subadult fish slowing as fish become older (Osmundson *et al.* 1997). The largest fish reach lengths between 900 and 1000 mm (35 to 39 in.); these fish are quite old, likely being 47 to 55 years old with a minimum of 34 years (Osmundson *et al.* 1997).

Reproductive success and recruitment of Colorado pikeminnow is pulsed, with certain years having highly successful productivity and other years marked by failed or low success (U.S. Fish and Wildlife Service 2002a). The most successful years produce a large cohort of individuals that is apparent in the population over time. Once individuals reach adulthood, approximately 80 to 90 percent of adults greater than 500 mm (20 in.) survive each year (Osmundson *et al.* 1997; Osmundson and White 2009). Strong cohorts, high adult survivorship, and extreme longevity are likely life history strategies that allow the species to survive in highly variable ecological conditions of desert rivers.

Status Review of Colorado pikeminnow

The Upper Colorado River Endangered Fish Recovery Program (Recovery Program) measures population dynamics of Colorado pikeminnow separately in the Green, upper Colorado, and San Juan River basins because distinct recovery criteria are delineated for each of these three basins(U.S. Fish and Wildlife Service 2002a). In the 2002 recovery plan, preliminary abundance estimates for wild adults in the basins were: upper Colorado River, 600 to 900; Green River, 6000 to 8000; and San Juan River, 19 to 50 (circa 2000 references for individual rivers found in U.S. Fish and Wildlife Service 2002a).

Green River Basin

The Recovery Program conducts population monitoring on five river reaches in the Green River Basin: (1) the Yampa River; (2) the White River; (3) the middle Green River (16 km downstream of the Yampa confluence to upstream of the White River confluence); (4) the Desolation-Gray Canyon stretch of the Green River; and (5) the lower Green River (near the town of Green River downstream to the Colorado River confluence) (Bestgen *et al.* 2005). Population estimates demonstrated an apparent decline in fish greater than 400 mm in all reaches from 2000 to 2003 (Figure 8) (Bestgen *et al.* 2005). Declines were greatest in river reaches that supported the highest numbers of individuals (59 and 63 percent decline in the middle Green and White Rivers, respectively), but declines were still evident in the other three reaches (29, 11, and 36 percent declines in the Yampa River, Desolation-Gray Canyon, and lower Green River, respectively) (Bestgen *et al.* 2005). Basin-wide adult Colorado pikeminnow abundance estimates apparently declined from 4,084 in 2000 to 2,142 in 2003, an apparent reduction of 48 percent (Bestgen *et al.* 2005).

The apparent decline in abundance was likely caused, in part, by low recruitment rates which were not able to offset adult mortality (Bestgen *et al.* 2005). Low recruitment may be a product of weak year-classes of age-0 fish produced in nursery areas of the middle and lower Green River over previous years (Bestgen *et al.* 2005). However, survival rates for adult fish from 2000 to 2003 were only approximately 65 percent, which was lower than historic estimates (82 percent) or estimates from the upper Colorado River (~85 percent) (Bestgen *et al.* 2005). Therefore, apparent declines in populations were also tied to higher adult mortality. While mechanisms are unknown, it seems that low, drought-related base flows were related to apparent reductions in adult and recruit-sized fish, resulting in an overall decline in abundance (Bestgen *et al.* 2005).

The Recovery Program continued population sampling efforts from 2006 to 2008 and found a 50 percent increase in abundance of adult Colorado pikeminnow throughout the Green River Basin over the study period, and about a 70 percent increase over 2003 estimates (Bestgen *et al.* 2010). Annual point estimates from 2006 to 2008 indicate highest apparent abundance increases in Desolation-Gray Canyon, the middle Green River, and the White River (Bestgen *et al.* 2010). Abundance of adult Colorado pikeminnow was stable and low in the Yampa River during the 2006 to 2008 period, but populations showed continued decline since 2003 (Bestgen *et al.* 2010). Abundance of adult Colorado pikeminnow in the lower Green River declined over the study period, but abundance levels were higher than in the 2000 to 2003 period (Bestgen *et al.* 2010). Basinwide, adult Colorado pikeminnow abundance increased each year of the study, from 2,454 fish in 2006, 2,718 in 2007, and 3,672 in 2008 (Figure 8 & Table 1) (Bestgen *et al.* 2010).

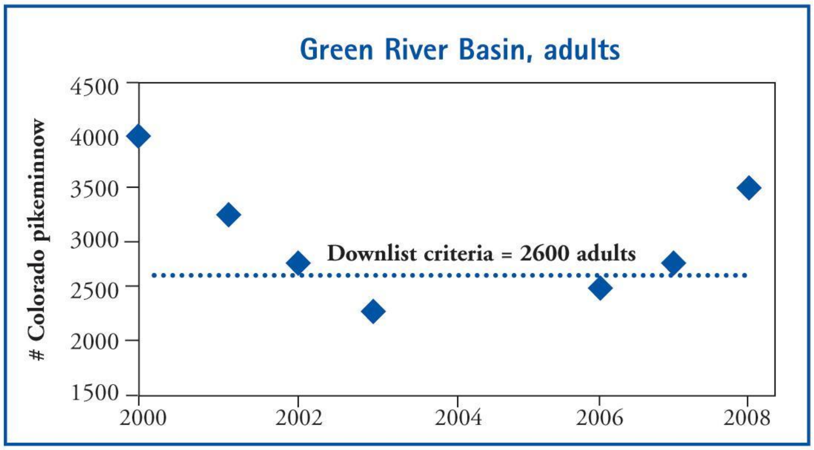


Figure 8. Colorado pikeminnow population trend in the Green River Basin from 2000 - 2008

Abundance estimates for recruit-sized fish during 2006 to 2008 were relatively high in the Green River Basin, and averaged 22 percent of estimated adult Colorado pikeminnow abundance (Bestgen *et al.* 2010). Recruitment rates were more than sufficient to offset mortality rates of adults, with most of the recruits apparently being produced in 2000 in the lower Green River when a large year-class of age-0 Colorado pikeminnow was produced by abundant adults (Bestgen *et al.* 2010). Survival rates from 2006 to 2008 averaged 80 percent, which are much greater than 2000 to 2003 (65 percent), and are in line with historic (82 percent) and upper Colorado River (~85 percent) estimates (Bestgen *et al.* 2010).

River Reach	Prior to 2000	2000	2001	2002	2003	2006	2007	2008
middle Green River		1613 1359-1948	1184 986-1441	834 593-1192	663 491-918	674 350-1422	1026 575-1901	1109 520-2444
Desolation-Gray Canyon			699 527-963	757 504-1166	621 423-942	519 350-813	484 307-793	1296 669-2580
lower Green River			355 270-496	261 184-388	227 154-352	791 617-1025	604 476-783	467 301-752
Yampa River		317 184-623	320 245-438	277 157-512	224 123-434	149 71-409	153 74-354	140 75-297
White River		1100 767-1653	746 586-973	643 491-864	407 300-573	321 207-548	451 309-691	660 355-1278
Entire Green River Basin	6000 to 8000	3030 2467-3592	3303 2900-3707	2771 2216-3325	2142 1686-2598	2454 1920-3185	2718 2055-3656	3672 2397-5715

Table 1. Colorado pikeminnow population estimates in the Green River Basin from 2000 to 2008

Duchesne River Basin

It has been reported that Colorado pikeminnow were historically found throughout the Duchesne River between the town of Myton and the Duchesne River - Green River confluence, although more fish were found in the lower reach below the Duchesne River - Uintah River confluence (Modde and Haines 2003). The earliest documented Colorado pikeminnow collections in the Duchesne River are from UDWR surveys in 1956 and 1968; captures were near the Duchesne River and Green River confluence, and at the confluence of the Duchesne and Strawberry Rivers (Cranny 1994). Since that time, fish were unable to use upstream habitats because of diversions and dams, the most significant being Starvation dam constructed in 1969. While sampling below Starvation dam in 1975, five Colorado pikeminnow were collected by the Ute Indian Tribe at the confluence of the Uintah and Duchesne Rivers (Seethaler 1978); and twenty one were collected by endangered fishes researchers downstream of river mile 3 from 1978 through June 1986. The farthest upstream that a Colorado pikeminnow has been collected after Starvation Dam's construction was by an angler on 12 July, 1989 eight miles upstream from the town of Myton (Cranny 1994). In 1993 UDWR sampled the river between the town of Myton and the confluence with the Green River and collected seven Colorado pikeminnow (Cranny 1994). And most recently, in 2010 one Colorado pikeminnow was surveyed near the town of Randlett by the Ute Indian Tribe (Fuller and Groves 2010).

Razorback sucker (*Xyrauchen texanus*)

The razorback sucker is listed as endangered under the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. 1531 *et. seq.*), under a final rule published on October 23, 1991 (56 FR 54957). The Service finalized the latest recovery plan for the species in 2002 (U.S. Fish and Wildlife Service 2002b), but is currently drafting an updated revision.

The largest native sucker to the western United States, the razorback sucker is a robust, river catostomid endemic to the Colorado River Basin (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002b). The species feeds primarily on algae, aquatic insects, and other available aquatic macroinvertebrates using their ventral mouths and fleshy lips (Sigler and Sigler 1996). Adults can be identified by olive to dark brown coloration above, with pink to reddish brown sides and a bony, sharp-edged dorsal keel immediately posterior to the head, which is not present in the young (Sigler and Sigler 1996; Figure 9). The species can reach lengths of 3 ft and weights of 16 pounds (7.3 kg), but the maximum weight of recently captured fish is 11 to 13 pounds (5 to 6 kg) (Sigler and Sigler 1996; U.S. Fish and Wildlife Service 2002b). Taxonomically, the species is unique, belonging to the monotypic genus *Xyrauchen*, meaning that razorback sucker is the only species in the genus (U.S. Fish and Wildlife Service 2002b).

Except during periods before and after spawning, adult razorback sucker are thought to be relatively sedentary and have high fidelity to overwintering sites (U.S. Fish and Wildlife Service 2002b). Adults become sexually mature at approximately 4 years and lengths of 400 mm (16 in.) (Zelasko *et al.* 2009), at which time they travel long distances to reach spawning sites (U.S. Fish and Wildlife Service 2002b). Mature adults breed in spring (mostly April–June) on the ascending limb of the hydrograph, congregating over cobble/gravel bars, backwaters, and impounded tributary mouths near spawning sites (multiple references in U.S. Fish and Wildlife Service 2002b; Snyder and Muth 2004; Zelasko *et al.* 2009). Flow and water temperature cues may play an important role prompting razorback adults to aggregate prior to spawning (Muth *et al.* 2000).

Figure 9. A razorback sucker collected in the Green River in April 2011

Status Review of the razorback sucker

Historically, the razorback sucker occupied the mainstem Colorado River and many of its tributaries from northern Mexico through Arizona and Utah into Wyoming, Colorado, and New Mexico (U.S. Fish and Wildlife Service 2002b). In the late 19th and early 20th centuries, it was abundant in the Lower Colorado River Basin and common in parts of the Upper Colorado River Basin, with numbers apparently declining with distance upstream (references in U.S. Fish and Wildlife Service 2002b). Distribution and abundance of razorback sucker declined throughout the 20th century across its historic range, and the species now exists naturally only in a few small, unconnected populations or as dispersed individuals. Specifically, razorback sucker are currently found in small numbers in the Green River, upper Colorado River, and San Juan River sub-basins; the lower Colorado River between Lake Havasu and Davis Dam; Lakes Mead and Mohave; in small tributaries of the Gila River sub-basin (Verde River, Salt River, and Fossil Creek); and in local areas under intensive management such as Cibola High Levee Pond, Achii Hanyo Native Fish Facility, and Parker Strip (U.S. Fish and Wildlife Service 2002b).

Razorback sucker have high reproductive potential, with reported average female fecundity of approximately 50,000 to 100,000 eggs per fish (U.S. Fish and Wildlife Service 2002b). They are broadcast spawners that scatter adhesive eggs over gravel-cobble substrate (Snyder and Muth 2004). High springs flows are important to egg survival because they remove fine sediment that can otherwise suffocate eggs. Hatching is limited at temperatures less than 10°C (50° F) and best around 20°C (68° F) (Snyder and Muth 2004). Eggs hatch 6 to 11 days after being deposited and larval fish occupy the sediment for another 4 to 10 days before emerging into the water column. Larval fish occupy shallow, warm, low-velocity habitats in littoral zones, backwaters, and inundated floodplains and tributary mouths downstream of spawning bars for several weeks before dispersing to deeper water (U.S. Fish and Wildlife Service 2002b; Snyder and Muth 2004). It is believed that low survival in early life stages, attributed to loss of nursery habitat and predation by non-native fishes, causes extremely low recruitment in wild populations (Muth *et al.* 2000).

Razorback sucker in the Upper Basin tend to be smaller and grow slower than those in the Lower Basin, reaching 100 millimeters (4 in.) on average in the first year (U.S. Fish and Wildlife Service 2002b). Based on collections in the middle Green River, typical adult size centers around 510 mm (20 in.) (Modde *et al.* 1996). Razorback suckers are long-lived fishes, reaching 40+ years via high annual survival (U.S. Fish and Wildlife Service 2002b). Adult survivorship was estimated to be 71 to 73 percent in the Middle Green River from 1980-1992 (Modde *et al.* 1996; Bestgen *et al.* 2002) and 76 percent from 1990 to 1999 (Bestgen *et al.* 2002).

Green River Basin

In the Upper Colorado River Basin, the razorback sucker has declined in distribution and abundance until it is now found in small numbers only in the middle Green River, between the confluences of the Duchesne and Yampa rivers, and in the lower reaches of those two tributaries (U.S. Fish and Wildlife Service 2002b). Population estimates during the 1980 to 1992 period were on average between 300 and 600 wild fish (Modde *et al.* 1996). By the early 2000s, the wild population consisted of primarily aging adults, with steep decline in numbers caused by extremely low natural recruitment (U.S. Fish and Wildlife Service 2002b). Although reproduction was occurring, very few juveniles were found (U.S. Fish and Wildlife Service 2002b). Population estimates from sampling efforts in the Middle Green River had declined to approximately 100 by 2002, with researchers hypothesizing that wild fish in the Green River Basin could become extirpated because of lack of recruitment (Bestgen *et al.* 2002).

Because of the low numbers of wild fish, the Service believed that augmenting the remaining wild populations with hatchery-raised fish is a key step to creating self-sustaining populations. In fact, the first management action for recovery of the species was to re-establish populations with hatchery-produced fish (U.S. Fish and Wildlife Service 2002b; Zelasko *et al.* 2009). Fish stocking programs (administered separately for the Upper Colorado and San Juan River Basins) have introduced thousands of fish into various river reaches in the San Juan, Colorado, and Green River sub-basins. In the Green River, over 150,000 fish have been stocked since 1995.

Although no formal monitoring has begun for razorback sucker population estimates, anecdotal information suggests that many stocked fish are surviving (5 year review). In addition, capture of larvae razorback sucker in the Green River indicate that reproduction is occurring. However, it is not known how larval production is affecting recruitment, and recruitment levels may still be low.

In 2011, reproduction was documented in the White River for the first time in many decades, even though no stocked razorback sucker are placed into this river. This indicates two important pieces of information: 1) razorback sucker are colonizing new areas outside of stocking locations; and 2) reproduction is occurring in new locations as the population of adults is expanding.

Duchesne River Basin

The earliest endangered Razorback sucker captures in the Duchesne River were recorded by BioWest in May 1978, when ten were collected at river mile 0.1. The next record is of 21 Razorback suckers captured by the Service between 1980 and 1984, between river mile 2.5 and the confluence with the Green River. Additionally, two razorback sucker were surveyed in 1993 (Cranny 1994), and a single Razorback sucker was surveyed by the Ute Indian Tribe in 2009 between the town of Randlett and the confluence with the Green River (Fuller and Groves 2009). In 2003 it was reported that most razorback sucker using the Duchesne River were located in the lower reach of the river (i.e., lower 0.6 river mile), and use seemed to be confined to the spring months immediately before and after spawning.

Bluehead sucker (*Catostomus discobolus*), flannelmouth sucker (*Catostomus latipinnis*), and roundtail chub (*Gila robusta*)

All three species are considered sensitive species in Utah (State of Utah Rule R657-48[4]), are similarly classified or proposed for similar classification in neighboring states, and are included in the U.S. Bureau of Land Management's (BLM) sensitive species list in Colorado, Utah, and Wyoming.

The three fish species to be covered under the CCAA portion of this Agreement are all in the order Cypriniformes. Roundtail chub are in the family Cyprinidae, the minnows, while flannelmouth sucker and bluehead sucker are in the family Catostomidae, the suckers. The Utah Comprehensive Wildlife Conservation Strategy identifies all three species as Tier I sensitive species (Sutter *et al.* 2005) and the UDWR manages the species under both a State Conservation Strategy and Range-wide Strategy (Utah Division of Wildlife Resources 2006a, 2006b). The agencies, including the UDWR, intend that the Strategy will identify conservation measures for the species and their habitats and will directly implement these actions, thus conserving the species and precluding their need for listing under the ESA[5].

Three Species Overview

Common characteristics of endemic, large-river fish including the three fish species are: fusiform bodies; leathery skins with embedded scales; and large, often falcate, fins. Researchers believe such morphological features, combined with relatively long life spans, are adaptations to the harsh, unpredictable physical environment of the Colorado River Basin (Scoppettone 1988; Bezzerides and Bestgen 2002). All three species reach relatively large sizes (~300 – 500 millimeters (mm)), are relatively long-lived, and are thought to require only sporadic recruitment to maintain population stability. Of the three fish species, flannelmouth sucker can demonstrate long-range movement (hundreds of stream miles) throughout the course of their lives, which is not generally observed for the other two species (Bezzerides and Bestgen 2002). The two catostomids are primarily benthic feeders (Muth and Snyder 1995; Sigler and Sigler 1996; Childs *et al.* 1998), whereas adult roundtail chub are frequently omnivorous (and can be piscivorous and insectivorous as large juveniles and adults) (Sigler and Sigler 1996).

Researchers have most often collected flannelmouth and bluehead suckers in large rivers, though tributary occurrences are often observed for both species. It is currently thought that they also use tributary streams for one or more life history stages (Maddux and Kepner 1988; Weiss *et al.* 1998). Although roundtail chub are known from past and present collections in mainstem habitats, such as the Colorado River, larger tributaries also provide important strongholds for roundtail chub, as demonstrated by their abundance in the White River (Lanigan and Berry 1981; Utah Division of Wildlife Resources 2009, 2010). Historical literature suggests that these three fishes were common to all of their historical localities within the Colorado River Basin up until the 1960s (Sigler and Miller 1963). Preceding the review of Bezzerides and Bestgen (2002), there had been no range-wide distribution or status assessments for any of these three species.

[4] See http://www.rules.utah.gov/publicat/code/r657/r657-048.htm. State of Utah Rule R657-48.

[5] The distinct population segment of the roundtail chub in the lower Colorado River basin was found to be warranted for listing, but precluded by higher priority actions and was therefore placed on the Service's candidate species list (50 FR 32352). However, this population does not occur in the vicinity of this Agreement.

Roundtail chub

Roundtail chub (Figure 10) utilize slow moving, deep pools for cover and feeding in the mainstems of major rivers and smaller tributary streams. They use a variety of substrate types (silt, sand, gravel, and rocks) and prefer murky water to clear (Sigler and Sigler 1996; Brouder *et al.* 2000).

Roundtail chub partition habitat use by life stage (adult, juvenile, and young-of-year (YOY)). Juveniles and YOY inhabit quiet water near shore, or backwaters with low velocity, and frequent pools rather than runs and riffles. Juveniles avoid depths greater than 100 centimeter (cm) and YOY avoid depths greater than 50 cm. Juveniles use instream boulders for cover, while YOY are found in interstices between and under boulders or the slack-water area behind boulders (Brouder *et al.* 2000).

Figure 10. A roundtail chub collected from the White River in 2009.

Adults generally do not frequent vegetation and avoid shallow water cover types (overhanging and shoreline vegetation) (Sigler and Sigler 1996; Brouder *et al.* 2000). Adults are found in eddies and pools adjacent to strong current and use instream boulders as cover (Sigler and Sigler 1996; Brouder *et al.* 2000). Adults occupy depths greater than 20 cm and select for velocities less than 20 centimeters per second. Adults commonly move 100 meter (m) or less over the course of a year, often in search of pool habitats (Brouder *et al.* 2000).

Roundtail chub mature at five years of age and/or 254 mm to 305 mm in length. Spawning begins in June to early July when water temperatures reach 18.3 degrees Celsius (°C). Three to five males may fertilize eggs from one female over gravel in water up to 9.1 m. A 305 mm female can produce 10,000 eggs, 0.7 mm in diameter. The eggs are pasty white and adhesive, sticking to rocks and other substrate or falling into crevices (Sigler and Sigler 1996).

Roundtail chub are omnivorous, opportunistic feeders. Documented food items include aquatic and terrestrial insects, fish, snails, crustaceans, algae, and occasionally lizards (Sigler and Sigler 1996).

Management agencies carefully consider their conservation actions because of potential hybridization among *Gila* species. In Utah, hybridization between humpback chub (*Gila cypha*) and bonytail (*G. elegans*) in Desolation and Gray Canyons of the Green River has been postulated by many observers (Kaeding *et al.* 1990; Douglas *et al.* 1998). Whether biologists and agencies recognize two species, two species and a hybrid form, three species, or some other combination has implications for how the fish are managed. Because roundtail chub are congeners with humpback chub and bonytail, the potential for hybridization between the species exists, though it has not been as well documented as humpback chub/bonytail hybrids. Valdez and Clemmer (1982) suggested hybridization is a result of dramatic environmental changes, while Dowling and DeMarais (1993) suggest that hybridization among these species has occurred continually over geologic time, providing additional genetic variability. Barriers to hybridization among some *Gila* species may illustrate that it is a paraphyletic genus (Cavender and Coburn and references therein).

Status Review of roundtail chub

Historical literature suggests that roundtail chub were common to all parts of the Colorado River Basin up to the 1960's (Sigler and Miller 1963). They are believed to have occurred in most faster flowing rivers and streams below 2,300 m elevation (Bezzerides and Bestgen 2002). While they continue to occupy a number of rivers and streams in the upper basin, declines in numbers and relative abundance have been observed in many of these locations (Bezzerides and Bestgen 2002).

Green River Basin

Roundtail chub abundance in the mainstem Green River and associated tributaries has declined since the installation of multiple water development projects beginning in 1902 (Bezzerides and Bestgen 2002). In addition to water development, the introduction of nonnative predators and competitors over the same time period has proven to be detrimental to the roundtail chub (Bezzerides and Bestgen 2002) as have the presence of oil exploration projects within the drainage. Flaming Gorge Dam is thought to have impacted roundtail chub at three sites on the mainstem Green River: Willow Creek, Little Hole, and Brown's Park. Roundtail chub were found at these locations in 1962, but not in 1964, 1965, 1966, or 2004 (UDWR unpublished). Also, recent surveys within the Dinosaur National Monument portion of the Green River show declines compared to previous sampling (Vanicek 1970).

In Northeastern Utah, the two main tributaries to the Green River are the White River and the Duchesne River. All previous sampling of roundtail chub in the White River demonstrated that the species was common to abundant (Holden and Stalnaker 1975; Lanigan and Berry 1981). Recent monitoring in the White River demonstrates that roundtail still comprise 1-7 percent of the catch depending on time of year and gear type (Utah Division of Wildlife Resources 2010). In fact, roundtail chub are found in greater numbers in the White River than in any other location in Utah (Utah Division of Wildlife Resources 2010).

Duchesne River Basin

In the Duchesne River, roundtail chub were described as abundant as late as 1975 (Holden and Stalnaker 1975) and common in 1982 (Tyus *et al.* 1982), but have since declined in numbers (Brunson and Chrisopherson 2003). The earliest recorded roundtail chub capture in the Duchesne River was in 1969, when six were collected during an electrofishing survey just below the Myton bridge on highway 40 (UDWR unpublished data). In 1975, Pettengill (1977) captured 26 Roundtail chubs in the Uintah River, and in 1976 Mullan reported capturing 141 Roundtail chubs north of the town of Myton. Mullan also reported 62 and 89 Roundtail chubs collected south of Myton and at the Uintah – Duchesne River confluence, respectively. In 1993, the UDWR reported a single captured Roundtail chub between Myton and the Duchesne River – Green River confluence (Cranny 1994). Additionally, a single Bonytail and a single Roundtail chub were surveyed in 2009 just below the town of Randlett (Fuller and Groves 2009). More recently, monitoring in 2009 documented one roundtail chub in the Duchesne River below the Myton Diversion (Utah Division of Wildlife Resources 2010).

Bluehead sucker

Bluehead suckers (Figure 11) are found in a variety of habitats. Adults prefer large, cool streams (20°C) with rocky substrates (Sigler and Sigler 1996), but are also found in warm, small creeks with maximum water temperatures of 28°C. Bluehead sucker are opportunistic omnivores, consuming algae, detritus, plant debris, and occasionally aquatic invertebrates (Sigler and Sigler 1996). This species feeds in riffles or deep rocky pools (Sigler and Sigler 1996).

Bluehead sucker mature at two years of age and/or at 127 to 179 mm in length. Spawning occurs in shallow areas when water temperatures reach 15.6°C. Time of spawning varies by elevation, i.e., spring and early summer at low elevations and warm water temperatures, and mid- to late summer at higher elevations and cooler temperatures (Sigler and Sigler 1996). Fecundity is related to length, body weight (Holden 1973), and water temperature (McAda 1977). Eggs hatch in seven days at water temperatures of 18 to 21°C (Holden 1973). During spawning, bluehead sucker will compress to the bottom of the stream when disturbed and may be captured by hand (Sigler and Sigler 1996).

Figure 11. A bluehead sucker collected from the Strawberry River (above Starvation Reservoir) in September 2010.

Status Review of bluehead sucker

Bluehead sucker historically occurred in the Colorado River basin, the Bonneville basin in Utah, and the Snake River basin in Idaho, Nevada, and Utah (Bezzerides and Bestgen 2002). Although bluehead sucker are considered common in the mainstem Green, San Rafael, Price, Duchesne, White, and San Juan Rivers and abundant in the mainstem Colorado and Dolores rivers, they presently occupy only approximately 45 percent of their historical range in the Upper Colorado River basin (Bezzerides and Bestgen 2002). Recent declines of bluehead sucker have occurred in the Duchesne River (Utah Division of Wildlife Resources 2010), the upper Green River (Holden and

Stalnaker 1975; Bezzerides and Bestgen 2002), and in lower portions of many tributaries to the Escalante River (Fridell et al. 2004, Morvilius and Fridell 2005).

Like the roundtail chub, the threats to the bluehead sucker are: water diversions, non-natives, and oil exploration projects that affect water quality. Non-natives in the basin include brown trout, northern pike, smallmouth bass, white sucker, green sunfish, red shiner, and walleye. Many higher elevation streams in the drainage that are suitable for bluehead sucker are also blue ribbon trout waters and thus are intended for sportfishing.

Green River Basin

Bluehead sucker are common in the mainstem Green River, hosting an abundance of reproductively mature adults which is indicative of a large spawning population. In addition, presence of fall YOY bluehead sucker indicates successful recruitment in this area. However, bluehead sucker are likely extirpated from a short stretch of the Green River below Flaming Gorge Dam because of modified habitat from reservoir releases (temperature and sediment alteration).

In Northeastern Utah, the two main tributaries to the Green River are the White River and the Duchesne River. Bluehead sucker are common to abundant in the White River (Bezzerides and Bestgen 2002; Utah Division of Wildlife Resources 2009, 2010). In fact, the White River produces some of the highest catch rates for bluehead sucker in the Northeastern Region (Utah Division of Wildlife Resources 2009, 2010).

Duchesne River Basin

Contrasting with the White River, bluehead sucker presence in the mainstem Duchesne River has greatly declined over the past decades. While the Duchesne River historically was an important tributary for bluehead sucker, during multiple surveys in 2009, no bluehead sucker and one bluehead/ white sucker hybrid was documented, indicating a substantial decline in the bluehead sucker population in the Duchesne River (Utah Division of Wildlife Resources 2010). However, in the Strawberry River drainage (a tributary to the Duchesne River) bluehead sucker are abundant at all age classes. They occupy portions of the drainage above Starvation Reservoir and have been found up to approximately 6,500 ft which is roughly where brown trout begin to dominate the species assemblage (Utah Division of Wildlife Resources 2009).

Flannelmouth sucker

Flannelmouth suckers (Figure 12) reside in mainstem and tributary streams. Elements of flannelmouth sucker habitat include 0.9 to 6.1 m deep murky pools with little to no vegetation and deep runs and riffles (McAda 1977; Sigler and Sigler 1996; Bezzerides and Bestgen 2002). Preferred substrates consist of gravel, rock, sand, or mud (McAda 1977; Sigler and Sigler 1996). Flannelmouth sucker partition habitat use by life stage, with young fish occupying quiet, shallow riffles and near-shore eddies, and adults occupying deep riffles and runs. Flannelmouth sucker are opportunistic, benthic omnivores consuming algae, detritus, plant debris, and aquatic invertebrates (McAda 1977; Sigler and Sigler 1996; Bezzerides and Bestgen 2002). Food consumed depends on availability, age class, and time of season (Sigler and Sigler 1996).

Flannelmouth sucker mature at four or five years of age with males maturing earliest (McAda 1977; Sigler and Sigler 1996). Females ripen at water temperatures of 10°C, whereas males ripen earlier in the spring (6.1 to 6.7°C) and remain fertile for a longer period of time (McAda 1977;

Sigler and Sigler 1996). Seasonal migrations are made in the spring to suitable spawning habitat (Chart and Bergersen 1992; Sigler and Sigler 1996; McKinney *et al.* 1999). Chart and Bergersen (1992) documented long-range movements (~98-231 kilometers (km)) among adult and sub-adult fish, although the roles these movements (and obstructions to such, i.e., dams) play in the life history of the fish are unclear. Many researchers suspect that flannelmouth sucker return to natal tributaries for the purpose of spawning (Weiss *et al.* 1998). Populations spawn for two to five weeks over gravel substrates. After fertilization, the eggs sink to the bottom of the stream and attach to substrate or drift between crevices (Sigler and Sigler 1996).

Figure 12. A flannelmouth sucker collected from the White River in July 2011

Status Review of flannelmouth sucker

Historical literature suggests that flannelmouth sucker were common to all parts of the Colorado River basin up to the 1960's (Sigler and Miller 1963; Minckley 1973). They are thought to remain in at least 50 percent of their historical range above Glen Canyon Dam (Bezzerides and Bestgen 2002). Flannelmouth sucker continue to be documented at all other sites.

Hybridization with nonnative white sucker is thought to be an increasing threat (McDonald *et al.* 2008). White sucker are common in the Green River and have been seen occasionally in smaller tributaries of the Green and Colorado Rivers. As the range of white sucker increases, it is thought that the range of the flannelmouth sucker will decrease, as hybridization between the two species is prevalent (Holden and Stalnaker 1975; Anderson and Stewart 2000; Bestgen and Crist 2000).

Threats posed to the flannelmouth sucker are similar to those of the other two species: diversions, non-native species, and oil exploration and its impacts to water quality. Flannelmouth sucker may be better able to locate adequate habitat, as they can be highly migratory (Bezzerides and Bestgen 2002) and therefore may be better at dealing with these threats than the other two species.

Green River Basin

The range of the flannelmouth sucker in the Green River Basin is most similar to that of the bluehead sucker. Flannelmouth sucker are considered to be common in the mainstem Green River (Bezzerides and Bestgen 2002), hosting an abundance of reproductively mature adults which is indicative of a large spawning population. In addition, presence of YOY flannelmouth sucker indicates successful recruitment in this area.

In Northeastern Utah, the two main tributaries to the Green River are the White River and the Duchesne River. Flannelmouth sucker are considered abundant in the White River, supporting some of the highest catch rates of any location.

Duchesne River Basin

In the Duchesne River, flannelmouth sucker are present but rare. Flannelmouth sucker are still found in many areas in the Duchesne River with higher densities in the Strawberry River above Starvation Reservoir. In fact, flannelmouth sucker are the most abundant of the three species in the Duchesne River, but are still not common in the basin, with a catch rate of 0.5 fish per hour from raft electrofishing surveys conducted below the Myton diversion in 2009 (Utah Division of Wildlife Resources 2010). During spring 2009 monitoring just below the Myton Diversion, eight flannelmouth sucker in spawning condition were captured, indicating an attempted spawning movement which was blocked by this barrier (Utah Division of Wildlife Resources 2010). The Description of Existing Conditions (see below) will discuss recent findings in the covered area.

DESCRIPTION OF MYTON FISH PASSAGE STRUCTURE:

General Description of Proposed Fish Passage Structure

The proposed fish passage structure will be composed of preferred a concrete vertical-slot fishway bypass oriented on the right bank of the project site immediately downstream of the existing point of diversion (See Appendix II). The fishway will consist of seven pools each having a maximum hydraulic drop of 0.4 feet. Each pool will have an 8-foot length and 6-foot width with the exception of the center turning pool which will have a length of 14-feet and a width of 6-feet. The fishway will turn on its center wall to reduce material quantities and the overall footprint of the facility. A fish entry pool will be located at the downstream end of the fishway and will possess two entrances at least 2-feet in width: oriented downstream and towards the center of the river. A fish exit pool will be located at the upstream end of the fishway and will include a debris rack to reduce entry of debris and trash into the fishway. Hydraulics will be controlled uniformly with single vertical slots at the entrance of each of the seven pools. The slot will have a width of 9-inches and will be continuous to the fishway floor. Adjustable sill blocks will be provided at the bottom of each slot to improve ladder performance at lower flow conditions. A conceptual plan of the fishway is provided as Appendix II. Conceptual sections and details of the structure are also provided in Appendix II.

Flow through the fishway is proportional to the depth of water at the vertical slot, width of the slot, and the slope of the fishway floor (i.e. amount of drop per pool). Given that water surface elevations are anticipated to range from a minimum of 5113.50 feet to a maximum of 5119.7 feet during the anticipated range of fish passage flows, the corresponding range of flows through the fishway are anticipated to be 5 to 40 cfs.

Description of Fishway Operation

The proposed fishway will operate on a seasonal basis which will coincide with the anticipated period of fish migration of April through September. During this period of time, it is anticipated that the fishway would operate when sufficient flow is available to supply water rights at the irrigation diversion in addition to the flows required to operate the fishway (See Agreement Figure 1). Given the current slot and sill configuration, some level of passage can be provided through the fishway with as little as 5 cfs. However, preferred fishway operation would occur when 9 to 10 cfs is available for fish passage. Table 2 shows how a mean daily river flow of 21 cfs is anticipated to occur over 90% of the time just to give context to when flows through fishway may need to be curtailed so that water rights are maintained.

Guide slots and flashboards will be provided as part of the project to "bulkhead-off" the entrance and exit to the ladder. This can be performed by the tribe or the water users to simply stop flow through the ladder, manage sediment entrainment, and/or when necessary to perform periodic maintenance of the facility.

Table 2. Probability of daily exceedence for Duchesne River discharge at the project site.

River Discharge (cfs)	Probability of Exceedence (percent)
1	99.9
21	90.0
192	50.0
361	20.0
671	10.0
1,263	5.00
2,125	2.00
2,719	1.00

Selective Fish Passage and Monitoring

One cause of concern to building a fish passage structure is the transfer of certain non-native fish (e.g. smallmouth bass, white sucker, channel catfish, common carp, small-bodied cyprinids) from the lower Duchesne River, where they are abundant, above Myton Diversion, where they are absent or present in low numbers. To minimize this threat, the Parties have chosen a selective fish passage design that will restrict upstream movement of non-native fish. This will allow native fish to access upstream portions of the Duchesne River where habitats will offer less competitive and predatory pressure. In addition, it will limit hybridization between upstream populations of native fish with downstream populations of non-native fish (i.e.: nonnative white sucker hybridizing with native bluehead and flannelmouth suckers).

Holding pools will be provided for upstream and downstream migrating fish to facilitate selective fish passage and biological monitoring. The holding pools can be implemented by adding a series of perforated plate panels to the proposed structure. Two panels will possess fyke or conical openings that will act to allow passage in only one direction. A center panel can be added to segregate upstream and downstream migrants. Grated walkways will be provided to improve overhead access by monitoring personnel to facilitate dip-netting and handling of fish. The holding pool configuration is shown in Appendix II.

DESCRIPTION OF FLOW RECOMMENDATIONS:

Flow recommendations for the Duchesne River are called for in the Service's May 4, 2005 "Update to the Reasonable and Prudent Alternative (RPA) in the July 1998 Biological Opinion for the Duchesne River Basin" (2005 Amendment). The 2005 Amendment amended the original 1998 biological opinion with up-to-date information on the biology and habitat usage of Colorado pikeminnow and razorback sucker, and refined flow recommendations in the Duchesne River for the two species. Both base flow and high flow recommendations were established, with base flow recommendations based on biological productivity and fish movement and high flow recommendations based on channel maintenance principles.

The base flow recommendations provided in the 2005 Amendment are prioritized targets to be met in the Duchesne River at the USGS Randlett gaging station (Randlett Gage). As targets, it is recognized that significant flow fluctuations above and below the established values will occur due to the interrelated complexity of canal operations, weather patterns, and system geographical extent. However, it is the goal of the DRWG to learn how to avoid significant fluctuations below the targets and to continually work towards meeting the base flow recommendations. These prioritized recommendations, as established in the 2005 Amendment (in the document's Appendix A on page 8), are as follows:

1) Highest priority should be given to implementing actions to meet the 50 cfs aquatic productivity base flow during the months of July through October. Maintaining habitat during the summer growing season will likely provide the greatest benefit to organisms that are important to aquatic productivity in the river system.
2) Consideration should be given to enhancing flows to meet a 50 cfs target during the months of March through June during low flow years. Providing minimum flows during those months would enhance the aquatic productivity of the system by providing favorable conditions for aquatic production early in the growing season.
3) During extreme low flow years, water supplies, if available, should be managed to meet a 50 cfs target during the winter months of November through February. Providing a flow of at least 50 cfs during the winter months would help prevent winter kill of organisms and loss of habitat through desiccation.
4) Consideration should also be given to supplementing flows to meet passage requirements (115 cfs) for Colorado pikeminnow during the March through June period if water is available. However, base flows to maintain aquatic productivity are considered a higher priority.

In addition to providing a framework for base flow delivery priorities, the Service stated the following to recognize the challenges associated with meeting flow recommendations in the Duchesne River:

> "The USFWS recognizes that the flow recommendations may not be achievable in all years. However, by using the recommendations as a framework to help guide flow management in the system, conditions can be improved for the endangered fishes such that the Duchesne can contribute to the overall recovery of the Colorado pikeminnow and razorback sucker."

High flow recommendations attempt to provide the geomorphic processes that form and maintain adequate fish habitat. Proper geomorphic processes mobilize bed load, maintain channel movement, and transport fine sediment. The recommendations are based on an evaluation of the high flows that occurred during the 1977-2002 period of record and the response of sediment and other channel characteristics to these flows. The evaluation determined that an average annual channel-forming stream volume of at least 7,000 cfs-days per year above 4,000 cfs is sufficient to promote channel migration and maintain channel integrity[6]. The 2005 Amendment's high flow recommendation is to maintain a running average of 7,000 cfs-days above 4,000 cfs.

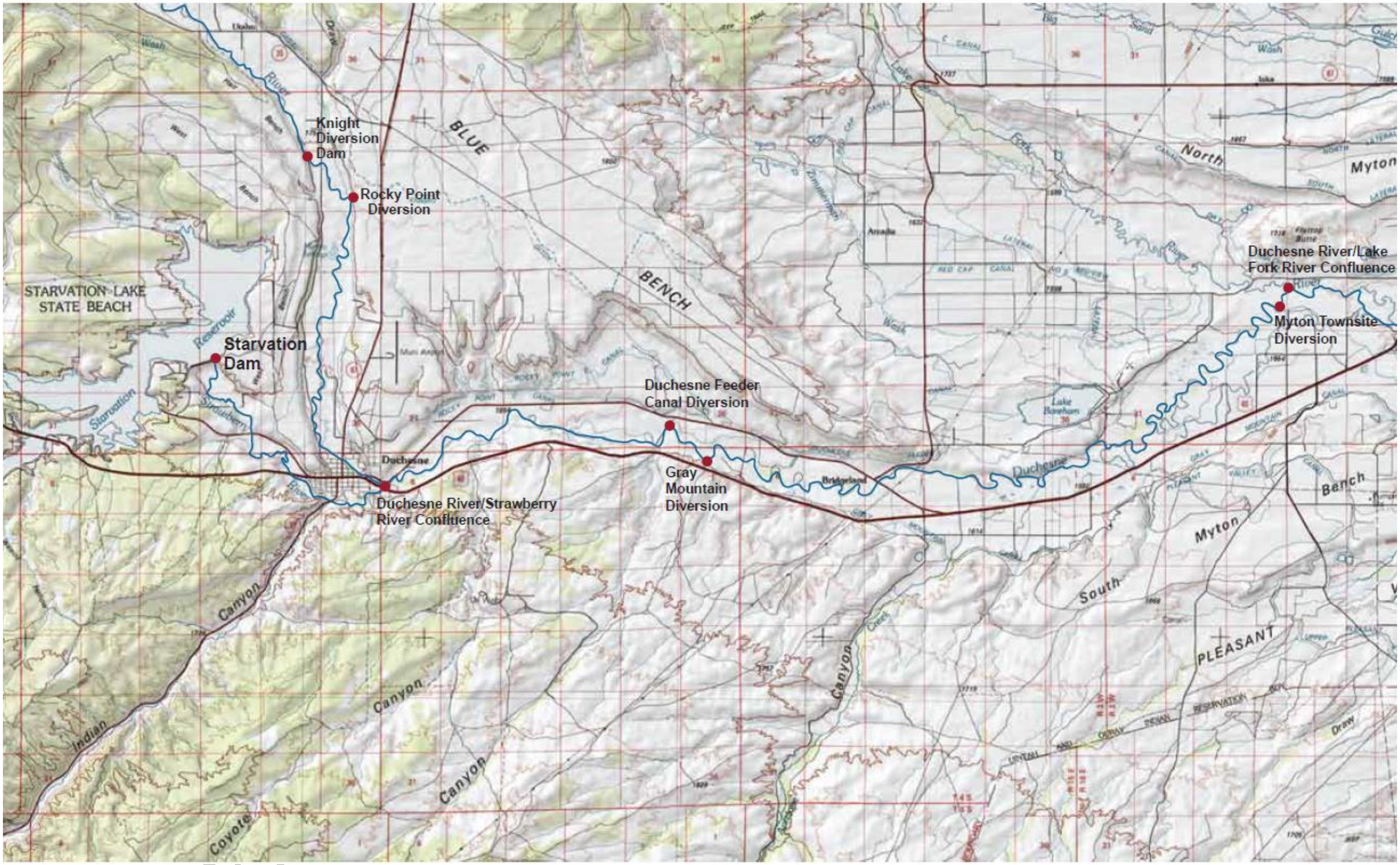
Based on additional analysis of the 1977 to 2005 period of record, the 2005 Amendment indicated that no special or extraordinary management is considered necessary to meet the high flow component of these recommendations. Since 2004, two years (2005 and 2011) have produced flow events generating cfs-days above 4,000 cfs. In 2005, there were 34,190 cfs-days above 4,000 cfs and 2011 produced 95,400 cfs-days above 4,000 cfs. With these two years, the current running average, as of 2011, is 21,598 cfs-days[7]. This total is much greater than the required 7,000 cfs-days average. In fact, the running average requirement will be maintained without any additional high flow events until the year 2022.

Because the flow recommendations are based on comprehensive scientific investigations and support all of the covered species, the Parties agree that working towards consistently meeting the flow recommendations will offer biological conservation value for the covered species. It is the goal of this CCAA/SHA to continue working toward meeting these flow recommendations as often as practical.

[6] A cfs-day is one cfs per day above 4,000 cfs. For example, an average daily flow of 5,000 cfs provides 1,000 cfs-days.
[7] (34190+95400)cfs-days/6 years = 21,598 cfs-days per year.

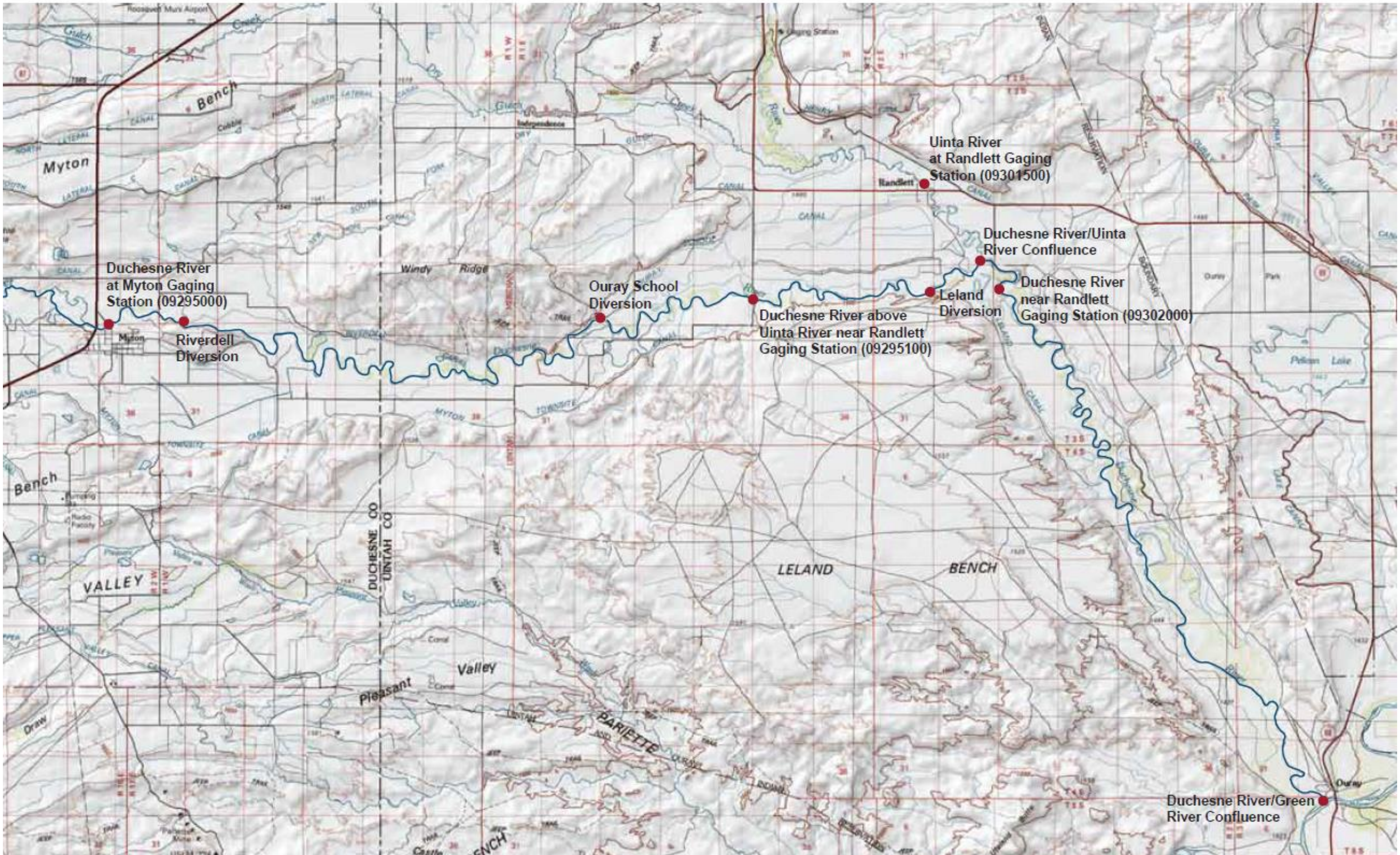
Appendix I: Duchesne River

Starvation Dam to Myton Townsite Diversion

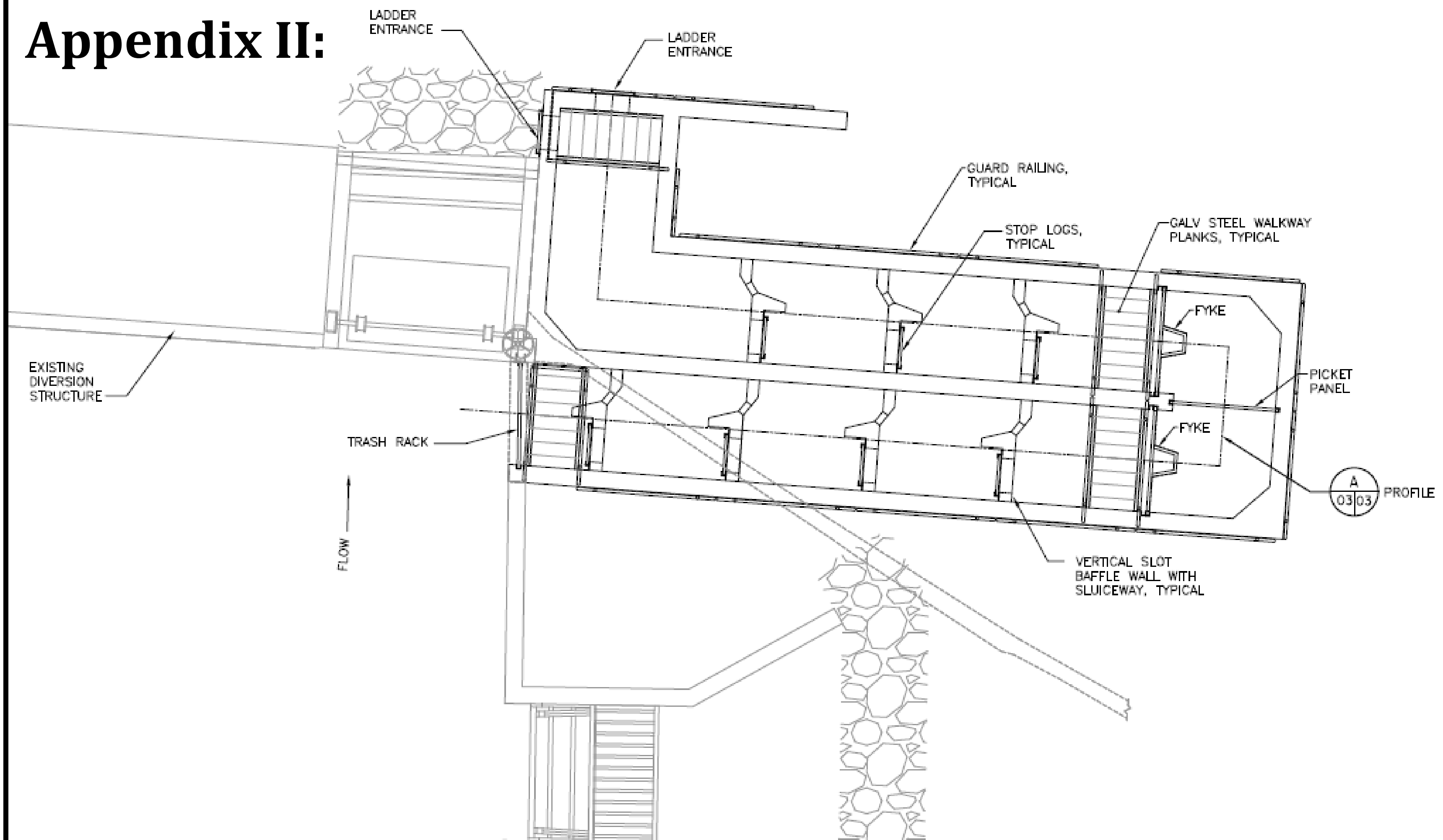


Appendix I: Duchesne River

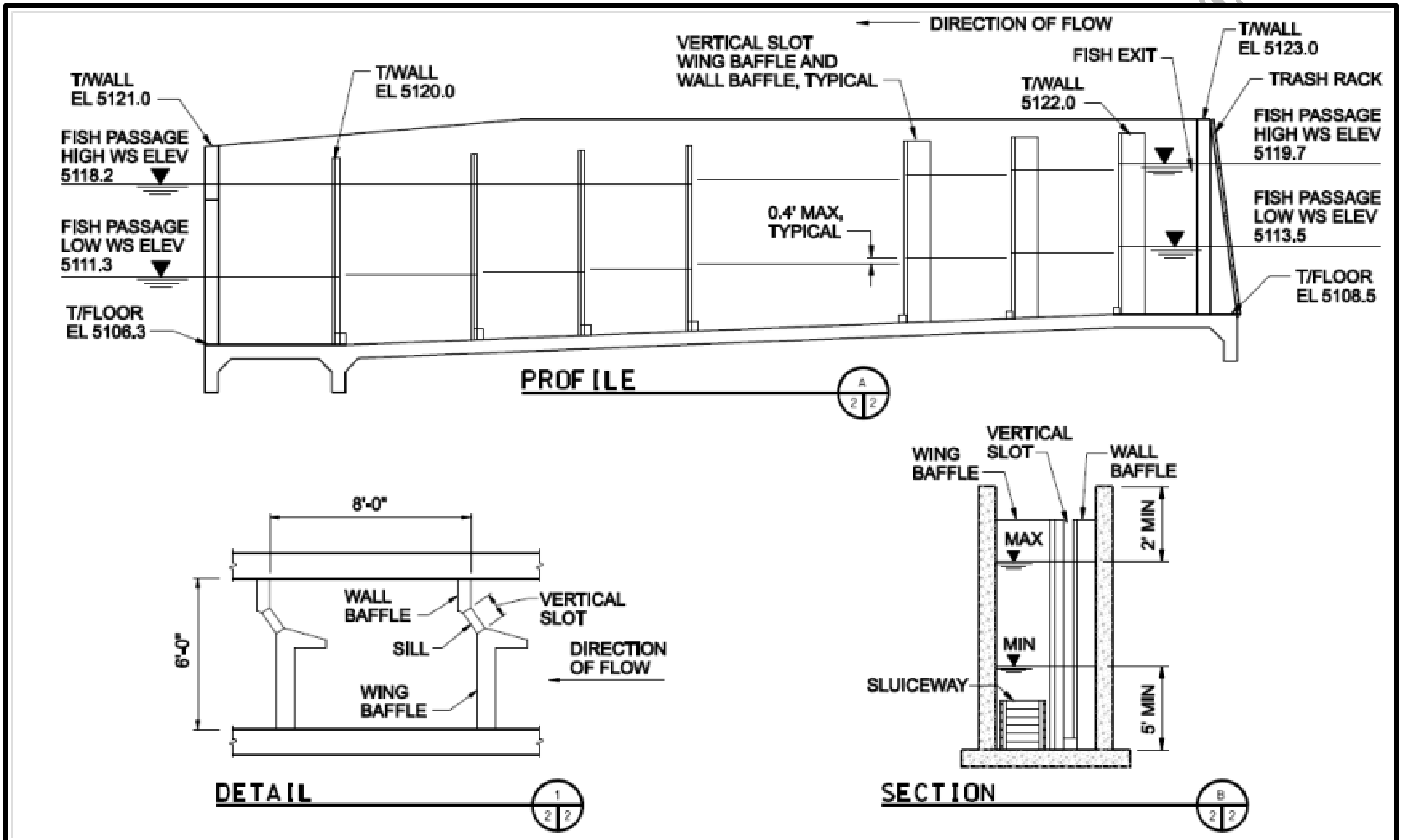
Myton City to Duchesne River/Green River Confluence



Appendix II:



Conceptual plan of the preferred alternative



Conceptual sections and details of the preferred alternative

Literature Cited

Anderson, R. & G. Stewart. 2000. Riverine fish flow investigations. Fort Collins, Colorado: Federal Aid Project F-289-R3. 96 pages.

Bestgen, K. R. & Larry W. Crist. 2000. Response of the Green River fish community to construction and re-regulation of Flaming Gorge Dam, 1962-1996 Final Report to Colorado River Recovery Implementation Program, Project Number 40. 74 pages.

Bestgen, K. R., J. A. Hawkins, G. C. White, K. Chrisopherson, M. Hudson, M. H. Fuller, D. C. Kitcheyan, R. Brunson, P. Badame, G. B. Haines, J. Jackson, C.D. Walford, T. A. Sorenson & T. B. Williams. 2005. Population status of Colorado pikeminnow in the Green River Basin, Utah and Colorado. Colorado River Recovery Implementation Program Project Numbers 22i and 22j. 113 pages.

Bestgen, K. R., J. A. Hawkins, G. C. White, C.D. Walford, P. Badame & L. Monroe. 2010. Population Status of Colorado pikeminnow in the Green River Basin, Utah and Colorado, 2006-2008. Colorado River Recovery Implementation Program Project Number 128. 112 pages.

Bestgen, Kevin R., G. Bruce Haines, Ronald Brunson, Tom Chart, Melissa Trammell, Robert T. Muth, G. Birchell, K. Chrisopherson & J. M. Bundy. 2002. Status of Wild Razorback Sucker in the Green River Basin, Utah and Colorado, Determined from Basinwide Monitoring and Other Sampling Programs. Colorado River Recovery Implementation Program Project Number 22D. 79 pages.

Bezzerides, Nick & Kevin R. Bestgen. 2002. Status review of roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and bluehead sucker (*Catostomus discobolus*) in the Colorado River Basin. 139 pages.

Brouder, Mark J., Diana Rogers & Lorraine Avenetti. 2000. Life History and Ecology of the Roundtail Chub *Gila Robusta*, From Two Streams in the Verde River Basin. Arizona Game and Fish Department. Federal Aid in Sportfish Restoration Project F-14-R. 24 pages.

Brunson, R. & K. Chrisopherson. 2003. Early life-stage and fish community investigations in the Lower Duchesne River, 1997-1999. Submitted to the Recovery Implementation Program for the Recovery of Endangered Fishes in the Upper Colorado River Basin. Final Report, Project No. 84-3. pages.

Cavender, Ted & Miles Coburn. Phylogenetic Relationships of North American Cyprinidae. In: Mayden RL, editor. Systematics, Historical Ecology, and North American Freshwater Fishes. Stanford, California: Stanford University Press. p 293-327.

Chart, Thomas E. & Eric P. Bergersen. 1992. Impact of Mainstream Impoundment on the Distribution and Movements of the Resident Flannelmouth Sucker (Catostomidae: Catostomus latipinnis) Population in the White River, Colorado. The Southwestern Naturalist 37:9-15.

Childs, Michael R., Robert W. Clarkson & Anthony T. Robinson. 1998. Resource Use by Larval and Early Juvenile Native Fishes in the Little Colorado River, Grand Canyon, Arizona. Transactions of the American Fisheries Society 127:620-629.

Cranny. 1994. Lower Duchesne River fishery investigations - 1993. Utah Division of Wildlife Resources. pages.

Douglas, Michael E., Robert R. Miller & W. L. Minckley. 1998. Multivariate Discrimination of Colorado Plateau Gila spp.: The "Art of Seeing Well" Revisited. Transactions of the American Fisheries Society 127:163-173.

Dowling, Thomas E. & Bruce. D. Demarais. 1993. Evolutionary significance of introgressive hybridization in cyprinid fishes. Nature 362:444-446.

Fridell, Richard A., Megan K. Morvilius & Kevin K. Wheeler. 2004. Inventory and Distribution of Fish In The Escalante River and Tributaries, Grand Staircase-Escalante National Monument, Utah 2003. Salt Lake City, Utah: 50 pages.

Fuller, M. H. & Jay Groves. 2009. Duchesne River Fishery Survey. Ute Indian Tribe. Project 154 Annual Report. pages.

Fuller, M. H. & Jay Groves. 2010. Duchesne River Fishery Survey. Ute Indian Tribe. Project 154 Annual Report. pages.

Holden, P.B. 1973. Distribution, abundance and life history of the fishes of the Upper Colorado River Basin. Utah State University. Logan, Utah. 59 pages.

Holden, Paul B. & Clair B. Stalnaker. 1975. Distribution and Abundance of Mainstream Fishes of the Middle and Upper Colorado River Basins, 1967-1973. Transactions of the American Fisheries Society 104:217-231.

Kaeding, Lynn R., Bob D. Burdick, Patricia A. Schrader & Charles W. McAda. 1990. Temporal and Spatial Relations between the Spawning of Humpback Chub and Roundtail Chub in the Upper Colorado River. Transactions of the American Fisheries Society 119:135-144.

Lanigan, Steven H. & Charles R. Berry, Jr. 1981. Distribution of Fishes in the White River, Utah. The Southwestern Naturalist 26:389-393.

Maddux, Henry R. & William G. Kepner. 1988. Spawning of Bluehead Sucker in Kanab Creek, Arizona (Pisces: Catostomidae). The Southwestern Naturalist 33:364-365.

McAda, C.W. 1977. Aspects of the life history of three Castostomids native to the Upper Colorado River Basin. Utah State University. Logan, Utah. 104 pages.

McDonald, David B., Thomas L. Parchman, Michael R. Bower, Wayne A. Hubert & Frank J. Rahel. 2008. An introduced and a native vertebrate hybridize to form a genetic bridge to a second native species. Proceedings of the National Academy of Sciences 105:10837-10842.

McKinney, Ted, William R. Persons & Roland S. Rogers. 1999. Ecology of flannelmouth sucker in the Lee's Ferry tailwater, Colorado River, Arizona.

Minckley, W. L. 1973. Fishes of Arizona. Phoenix, Arizona: Sims Printing Company, Inc.

Modde, Timothy, Kenneth P. Burnham & Edmund J. Wick. 1996. Population Status of the Razorback Sucker in the Middle Green River (U.S.A.). Conservation Biology 10:110-119.

Modde, Timothy & G. B. Haines. 2003. Adult fish use in the Duchesne River below Myton, 1997-2000. Recovery Implementation Program for Endangered Fishes Species in the Upper Colorado River Basin, Project No. 84-3. pages.

Morvilius, Megan K. & Richard A. Fridell. 2005. Inventory and Distribution of Fish In The Escalante River and Tributaries, Grand Staircase-Escalante National Monument, Utah 2003-2004. Salt Lake City, Utah: 42 pages.

Mullan, J. W. 1976. Smallmouth Bass: Special Administrative Report. U.S. Fish and Wldlife Service. Vernal, Utah. 132 pages.

Muth, Robert T., Larry W. Crist, Kirk E. LaGory, John W. Hayse, Kevin R. Bestgen, Thomas P. Ryan, Joseph K. Lyons & Richard A. Valdez. 2000. Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam: Upper Colorado River Endangered Fish Recovery Program, Project FG-53.

Muth, Robert T. & Darrel E. Snyder. 1995. Diets of young Colorado squawfish and other small fish in backwaters of the Green River, Colorado and Utah. Great Basin Naturalist 55:95-104.

Osmundson, D. B., R. J. Ryel & T. E. Mourning. 1997. Growth and survival of Colorado squawfish in the Upper Colorado River. Transactions of the American Fisheries Society 126:687-698.

Osmundson, Douglas B. & Gary C. White. 2009. Population Status and Trends of Colorado Pikeminnow of the Upper Colorado River, 1991–2005. Grand Junction, Colorado: U. S. Fish and Wildlife Service. 111 pages.

Pettengill, T.D. 1977. Fisheries Resources Inventory for Uintah Unit of Central Utah Project (Final Report). Utah Division of Wildlife Resources. 211 pages

Scoppettone, G. Gary. 1988. Growth and Longevity of the Cui-ui and Longevity of Other Catostomids and Cyprinids in Western North America. Transactions of the American Fisheries Society 117:301-307.

Seethaler, Karl. 1978. Life History and Ecology of the Colorado Squawfish (Ptychocheilus lucius) in the Upper Colorado River Basin. Utah State University. Logan, Utah. 156 pages.

Sigler, William F. & Robert R. Miller. 1963. Fishes of Utah. Salt Lake City, Utah: Utah State Department of Fish and Game.

Sigler, William F. & John W. Sigler. 1996. Fishes of Utah: A Natural History. Salt Lake City, Utah: University of Utah Press.

Snyder, Darrel E. & Robert T. Muth. 2004. Catostomid fish larvae and early juveniles of the upper Colorado River basin - morphological descriptions, comparisons, and computer-interactive key. Colorado Division of Wildlife Technical Publication 42. 122 pages.

Sutter, Janet V., Matthew E. Anderson, Kevin D. Bunnell, Michael F. Canning, Alan G. Clark, Dana E. Dolsen & Frank P. Howe. 2005. Utah Comprehensive Wildlife Conservation Strategy. Salt Lake City: Utah Division of Wildlife Resources. 281 pages.

Tyus, H. M., Bob D. Burdick, Richard A. Valdez, C.M. Haynes, T. A. Lytle & Charles R. Berry. 1982. Fishes of the Upper Colorado River Basin: distribution, abundance, and status. In: Miller WH, Tyus HM, Carlson CA, editors. Fishes of the Upper Colorado River System: Present and Future. Albuquerque, New Mexico: Western Division of the American Fishieries Society. p 12-70.

U.S. Fish and Wildlife Service. 2002a. Colorado pikeminnow (*Ptychocheilus lucius*) Recovery Goals: amendment and supplement to the Colorado Squawfish Recovery Plan. Denver, Colorado: US Fish and Wildlife Service, Mountain-Prairie Region. 111 pages.

U.S. Fish and Wildlife Service. 2002b. Razorback Sucker (*Xyrauchen texanus*) Recovery Goals: amendment and supplement to the Razorback Sucker Recovery Plan. Denver, Colorado: US Fish and Wildlife Service, Mountain-Prairie Region. 113 pages.

Utah Division of Wildlife Resources. 2006a. Conservation and Management Plan for Three Fish Species in Utah: Addressing needs for roundtail chub (*Gila robusta*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*). Salt Lake City: Utah Department of Natural Resources. 80 pages.

Utah Division of Wildlife Resources. 2006b. Range-wide Conservation Agreement and Strategy for Roundtail Chub *Gila robusta*, Bluehead Scuker *Gila discobolus*, and Flannelmouth Sucker *Catostomus latipinnis*. Colorado River Fish and Wildlife Council. 59 pages.

Utah Division of Wildlife Resources. 2009. Three Species Monitoring Summary: Statewide 2008. 127 pages.

Utah Division of Wildlife Resources. 2010. Three Species Monitoring Summary: Statewide 2009. 128 pages.

Valdez, Richard A. & G. H. Clemmer. 1982. Life history and prospects for recovery of the humpback and bonytail chub. In: Miller WH, Tyus HM, Carlson CA, editors. Fishes of the Upper Colorado River System: Present and Future. Albuquerque, New Mexico: Western Division of the American Fishieries Society. p 109-119.

Vanicek, C. David. 1970. Distribution of Green River Fishes in Utah and Colorado Following Closure of Flaming Gorge Dam. The Southwestern Naturalist 14:297-315.

Weiss, StevenJ, EdwardO Otis & O. Eugene Maughan. 1998. Spawning ecology of flannelmouth sucker, Catostomus lattipinnis (Catostomidae), in two small tributaries of the lower Colorado River. Environmental Biology of Fishes 52:419-433.

Zelasko, Koreen A., Kevin R. Bestgen & Gary C. White. 2009. Survival rate estimation and movement of hatchery-reared razorback suckers *Xyrauchen texanus* in the Upper Colorado River Basin, Utah and Colorado. Fort Collins, Colorado: 88 pages.